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Research Paper

Is there an optimal working capital management that minimizes European stock risk?

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ABTRACT

Purpose: This paper investigates the existence of an optimal point of the cash conversion cycle (CCC) and its components, which minimizes firms' stock risk.

Methodology: This study applies fixed effect models to a sample of firms listed in Euronext exchanges, from 2011 to 2019. Stock risk is proxied by the standard deviation of stock returns. The quadratic function of the CCC and its components (days sales outstanding – DSO, days sales inventory – DSI, and days payable outstanding – DPO) is applied to capture an optimal point of the working capital management (WCM).

Results: Results show the existence of a U-shaped relation between WCM and stock risk, suggesting the existence of an optimal CCC and DSI point that minimizes stock risk

Originality: To the best of our knowledge, this is the first paper that explores the existence of an optimal CCC point and also an optimal point of its components (DSO, DSI, and DPO), which minimizes stock risk. This paper is also the first to assess the impact of WCM on stock risk of firms listed in European stock exchanges. The results are also relevant to managers, shareholders, and investors since they demonstrate that firms can minimize the risk of their stocks by practicing an optimal WCM.

Keywords: *Working capital management; WCM; Stock risk; Cash conversion cycle; CCC; Inventories; DSI; Accounts payable; DPO; Accounts receivable; DSO; Euronext; Europe.*

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1. Introduction

Working Capital Management (WCM) helps firms to guarantee liquidity and profitability when conducting their day-to-day operations (Padachi, 2006). It is also an important issue in the management of firms' operational and financial risk, as demonstrated by Shin and Soenen (1998) when presenting the case of Kmart and Wal-Mart. Both firms had similar capital structures, but different cash conversion cycle (CCC): Kmart's CCC was 61 days, while Wal-Mart's was 40 days. This discrepancy led Kmart to incur external financing costs of $198 million per year to finance its CCC, which contributed to its bankruptcy.

Based on the assumption that markets are efficient, Fama (1991) advocated that stock prices should incorporate the information from financial statements, where WCM is also reflected. As a result, WCM not only affects stocks' specific risk, but also allows firms to react to unexpected market changes, such as changes in interest rates and in commodity prices (Appuhami, 2008), thus reducing systematic risk.

To date, research on the relation between WCM and stock risk is scarce and is mainly focused on the study of a linear relation that has been met with mixed evidence. Lee and Kim (1998), and Wang (2019) found a positive relation, while Le (2019) found a negative relation. The inconclusive evidence can be due to the fact that a linear relation neglects the trade-offs that have already been acknowledged by scholars (e.g., Abuzayed, 2012; Autukaite and Molay, 2011; Deloof, 2003; Padachi, 2006). A higher CCC allows firms to concede trade credit to clients, to boost their sales, while having a higher level of inventories that avoids stockout risk, and to pay earlier to suppliers to obtain discounts for those earlier payments. Nevertheless, a higher CCC can cause liquidity problems, implying a higher investment in working capital (WC), which leads to a greater need for external financing, increasing the risk of bankruptcy (Aktas et al., 2015; Altaf and Shah, 2018; Bolek, 2013; Deloof, 2003; Sagan, 1995). Hence, there is a trade-off between profitability and liquidity (Jose et al., 1996; Padachi, 2006), and both are sources of risk for firms (Bolek, 2013).

The lack of consensus in the empirical studies, conjugated with the trade-offs associated with WCM, naturally raises the question if there is an optimal WCM that minimizes stock risk?

The answer to this question depends on how firms manage the trade-offs of WCM components, which raises another important question: are there optimal points of WCM components? This paper aims to answer these two questions by studying a non-linear relation between CCC, its components, and stock risk.

This paper extends the prior work of Akbar et al. (2021) and Aktas et al. (2015) that found a non-linear relation between WCM and stock risk while studying Pakistan and United States (US), respectively. However, this paper is remarkably different from the previous ones. First, while previous studies limited their scope to either WC or CCC, this paper takes a step further, by also examining the existence of an optimal point of CCC components. This decomposition is necessary to understand whether the optimal point of the CCC is due to the simultaneous management of all components or whether it is a consequence of the optimal management of a single component. In this sense, this study provides a methodical analysis that sheds new light on the relation between WCM and stock risk. Second, this paper covers a sample of European firms, which is an empirical context that has not yet been explored. Studying the European context can be particularly relevant, since firms tend to practice longer CCC than US firms (PwC, 2019), which may impact how information about WCM is incorporated into stock risk. Therefore, this paper adds to the literature in two different ways. Firstly, it adds new empirical evidence that supports the existence of an optimal CCC that minimizes stock risk. Secondly, it explores a rich data set of European firms, addressing the gap of studies in the European context. Moreover, this paper also finds evidence of the existence of an optimal point of day sales of inventories (DSI) that minimizes stock risk, which suggests that the optimal management of inventories should be a part of an optimal WCM.

The findings of this paper have potential practical implications for managers, shareholders, and investors, who are trying to understand the link between WCM and stock risk. Accordingly, the results can enhance managers' decision-making by empirically proving the existence of a U-shaped relation between CCC, and DSI, and stock risk. It shows that managers should balance their investment in WC and inventories to minimize stock risk. From the shareholders' perspective, the results yield a further understanding of WCM, by specifying how the trade-offs of WCM influence the risk they must bear. The insights from this study might be particularly valuable for investors when selecting stocks for their portfolios since the findings suggest that including firms with an optimal CCC and DSI will minimize their portfolio risk.

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The paper proceeds as follows. Section 2 presents the literature review and research hypotheses. Then, the description of the research methodology, the explanation of the process of sample selection, and the definition of variables, are carried out in section 3. In section 4, the empirical results are presented and discussed. Finally, section 5 concludes.

2. Literature review

2.1. Working capital management

WC is the excess of current assets over current liabilities (Fazzari and Petersen, 1993). In this sense, WCM denotes the capacity of firms to control and plan, effectively and efficiently, their current assets and liabilities (Padachi, 2006), ensuring a balance between liquidity and profitability when conducting their day-to-day operations (Abuzayed, 2012; Autukaite and Molay, 2011; Padachi, 2006).

From another perspective, WCM also impacts the operational and financial risk of firms. Firms that choose to improve their profitability by using trade credit to boost their sales (Altaf and Shah, 2018) will reduce their operational risk. Similarly, firms with cash liquidity have a lower financial risk, since they have less need to resort to external financing (Aktas et al., 2015; Wang, 2019).

2.1.1. Cash conversion cycle

To capture WCM it is common to use CCC as a measure (Altaf and Shah, 2018; Deloof, 2003). The CCC captures the time interval between the purchase of raw materials and the receipt arising from the sales of finished goods or the provision of services (Gitman, 1974).

Firms can improve their liquidity by reducing their CCC (Jose et al., 1996), as they quickly recover cash from sales (Bolek, 2013). On the other hand, the higher the CCC, the higher the investment in WC (Deloof, 2003), leading to a greater need for external financing for firms to meet their obligations (Sagan, 1995). Consequently, that implies higher financial costs to be borne (Eljelly, 2004), increasing the risk of bankruptcy (Aktas et al., 2015; Altaf and Shah, 2018).

Even so, practicing a high CCC allows firms to improve their profitability through increased sales by granting credit, reducing stockout risk, and obtaining discounts for earlier payment from suppliers (Blinder and Maccini, 1991; Deloof, 2003; Gill et al., 2010; Jose et al., 1996;

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Shin and Soenen, 1998; Ukaegbu, 2014). However, a high CCC may lead to liquidity problems (Bolek, 2013). There is thus a trade-off between liquidity and profitability (Jose et al., 1996; Padachi, 2006), and both are sources of risk for firms (Bolek, 2013).

2.1.2. Days sales outstanding

The days sales outstanding (DSO) corresponds to the average number of days customers take to pay the firm and represents the firm's credit policy.

Firms are motivated to grant trade credit to promote their sales by financing customers with restricted access to the capital market or with high financing costs (Meltzer, 1960; Mian and Smith, 1992; Petersen and Rajan, 1997; Schwartz, 1974). Trade credit is also a legal way to practice price discrimination among customers (Meltzer, 1960; Mian and Smith, 1992; Petersen and Rajan, 1997; Schwartz, 1974), making it possible to distinguish the firms' products from their competitors, and promote sales (Altaf and Shah, 2018). This is also a way to improve the reputation of firms, making it easier to negotiate with their customers since they have the possibility to check the quality of the product before paying (Long et al., 1993).

The flip side of granting trade credit is that cash flow problems may occur due to the chance of uncollectible accounts (Ukaegbu, 2014), which also ties up funds in accounts receivable that could be left in a bank earning interest or invested elsewhere (Afrifa and Tingbani, 2018). Reducing DSO not only avoids these negative effects, but also makes more cash available for firms to pay their short-term obligations on time, reducing the likelihood of bankruptcy (Altaf and Shah, 2018; Autukaite and Molay, 2011).

2.1.3. Days sales of inventories

The DSI reflects the average number of days that inventories remain in storage and represents the firm's inventory policy.

Practicing a higher DSI reduces the risk of stockouts and production shortages (Blinder and Maccini, 1991; Deloof, 2003; Mathuva, 2010; Ukaegbu, 2014). Additionally, bulk purchasing of raw materials reduces supply costs and allows for obtaining quantity discounts (Afrifa and Tingbani, 2018; Blinder and Maccini, 1991; Mathuva, 2010).

On the other hand, investing in inventories absorbs funds needed for other areas (Abuzayed, 2012; Sagan, 1955). Additionally, the higher the level of inventories, the higher the costs of storage, insurance, and obsolescence (Afrifa and Tingbani, 2018; Altaf and Shah, 2018; Blinder and Maccini, 1991), factors that increase the uncertainty regarding firms' cash flows.

2.1.4. Days payable outstanding

The days payable outstanding (DPO) is the average number of days it takes a firm to pay its suppliers and reflects the firm's payment policy.

Firms are encouraged to seek trade credit to reduce the cost of paying for each order, to obtain more flexibility in planning their payments (Ferris, 1981), and to reduce late payment costs (Petersen and Rajan, 1997). Trade credit also represents a flexible and low-cost source of financing that allows firms to verify product quality before making payments (Abuzayed, 2012; Deloof, 2003; Gill et al., 2010).

However, the implicit cost of extending DPO is the loss of early payment discounts and flexibility for future supplier debt (Deloof, 2003; Gill et al., 2010; Jose et al., 1996; Ukaegbu, 2014).

In sum, WCM is met with multiple trade-offs. For example, extending CCC by conceding credit and maintaining higher inventory levels increases sales and minimizes stockout risk (Deloof, 2003), and contributes to reduce firms' operational risk. Nonetheless, the CCC extension can impair liquidity, leading to increased external financing needs, and, consequently, increasing financial risk and ultimately the likelihood of bankruptcy (Aktas et al., 2015; Altaf and Shah, 2018).

2.2. Relation between WCM and stock risk

Stock risk can be defined by the dispersion around the average stock returns, being decomposed into systematic risk and specific risk (Sharpe, 1964). Systematic risk affects the return of all stocks, described as the volatility of the stock market. In turn, the specific risk is the volatility caused by firm or industry-specific characteristics, such as, for example, the operational and financial risk of firms.

The relation between WCM and stock risk assumes that markets are efficient, and that the information presented in financial statements is incorporated into stock prices (Fama, 1991). Therefore, WCM decisions can be reflected in stock risk.

Additionally, WCM simultaneously impacts firms' operational and financial risk, allowing them to mitigate stockout risk and avoid the need for external financing (Aktas et al., 2015;

Wang, 2019). In this sense, according to Bolek (2013), the WCM strategy of firms affects stock specific risk. WCM also allows firms to react quickly and appropriately to unexpected market changes, such as changes in interest rates and commodity prices (Appuhami, 2008), and it can impact the systematic risk of stocks.

Lee and Kim (1998) were the first to relate WC and stock risk. When examining a sample of 727 listed firms in Korea, between 1981 and 1994, the authors found a positive relation between WC and total and systematic risk, meaning that the investment in WC increases stock risk as a result of the firms' increased business risk. More recently, Wang (2019) obtained similar results with a sample of US listed firms, evidencing the existence of a positive coefficient between CCC and firms' specific risk. However, the results showed that portfolios formed by firms with very extensive or very low CCC have, on average, a higher risk compared to firms with more moderate CCC.

When analysing a sample of 497 listed firms in Vietnam between 2007 and 2016, Le (2019) found a negative relation between CCC and total stock risk. Similar results were obtained by Akbar et al. (2021) when examining the impact of CCC on the systematic stock risk of listed firms in Pakistan.

The research of Aktas et al. (2015) focused on studying the relation between WC investment and the stock risk of 15,541 US listed firms between 1982 and 2011. The authors concluded that firms that invest in WC below their industry median have a higher risk, suggesting the existence of an optimal WC point that firms must reach to minimize their stock risk. This empirical result is also supported by the recent work of Akbar et al. (2021) when analysing the impact of WC on systematic stock risk in Pakistan.

Regarding inventory management, Mishra et al. (2013) investigated whether it is reflected in the stock risk of 394 US listed firms between 2002 and 2006 and found a negative relation between stock specific risk and inventory turnover.

A summary of the results of empirical studies on the influence of WCM on stock risk is presented in Table I.

Table I - Summary of empirical results on the relation between WCM and stock risk

Author(s)	Countries	Years	Risk measure	WCM measure	Relation
Lee and Kim (1998)	Korea	1981-1994	Total risk and systematic risk	*Log* (WC)	Positive
Le (2019)	Vietnam	2007-2016	Total risk	WC	Negative
Wang (2019)	US	1976-2015	Specific risk	CCC	Positive
Aktas et al. (2015)	US	1982-2011	Total risk	WC	Concave up
Akbar et al. (2021)	Pakistan	2005-2014	Systematic risk	CCC and WC	Negative and concave up
Mishra et al. (2013)	US	2002-2006	Specific risk	Inventory Turnover	Negative

Source: Own Elaboration

Ultimately, inadequate management of WCM trade-offs can cause bankruptcy, as demonstrated in the case presented by Shin and Soenen (1998). Thus, it becomes pertinent to study whether the risk reflected in financial statements resulting from WCM decisions is reflected in the risk of firms' stock, as advocated by Fama (1991).

The literature documenting the causal relation between stock risk and WCM is scarce and is mostly focused on the US, with the absence of studies of European countries. Furthermore, the empirical results are not unanimous. Akbar et al. (2021) and Le (2019) concluded that there is a negative relation between WCM and stock risk, while Lee and Kim (1998) and Wang (2019) found a positive relation. Additionally, the results of Akbar et al. (2021) and Aktas et al. (2015) proved the existence of an optimal WC point that minimizes risk.

The current research innovates by studying the existence of an optimal point for the CCC, as well as for its components, which minimizes the stock risk. In this sense, the hypotheses analysed are the following:

H1. There is an optimal CCC point that minimizes stock risk.

H1a. There is an optimal DSO point that minimizes stock risk.

H1b. There is an optimal DSI point that minimizes stock risk.

H1c. There is an optimal DPO point that minimizes stock risk.

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3. Methodology

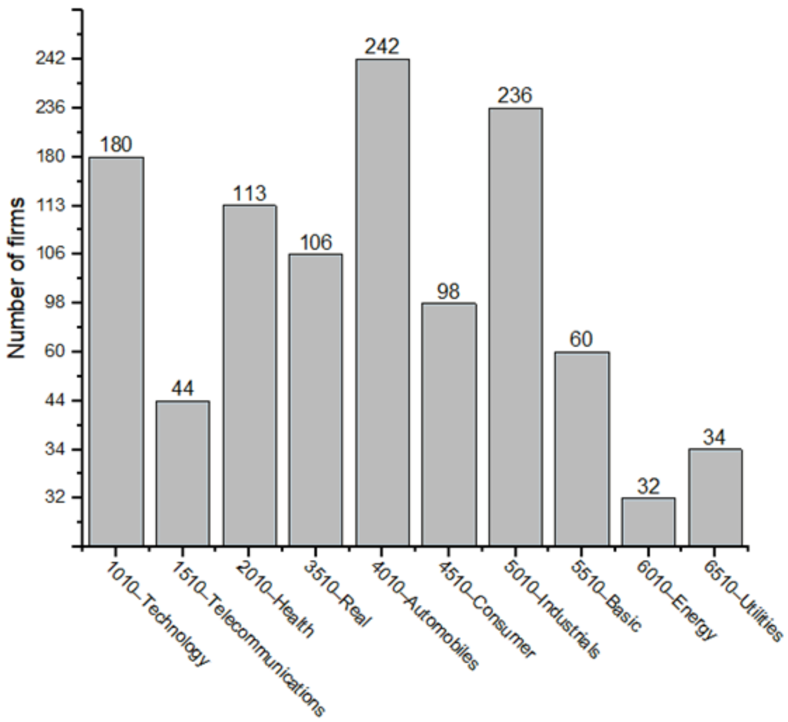
3.1. Sample and sources of information

The literature review reveals a lack of studies at the European level. European firms tend to practice longer CCC compared to US firms (PwC, 2019), which may have a different impact on how information about WCM is incorporated into the stock price. In this sense, this paper covers a sample of 1,145 firms listed in five Euronext exchanges (Amsterdam, Brussels, Dublin, Lisbon, and Paris), between January 1st, 2011, and December 31st, 2019.

Daily market data was obtained from Eikon-Datastream and annual accounting data from Orbis database. Due to legislation, accounting, and WCM practices, firms belonging to the financial sector were excluded, as applied by Deloof (2003) and Wang (2019). Additionally, firms without data in Eikon-Datastream and Orbis were eliminated. To mitigate the influence of outliers, a winsorization of 5% was performed. To avoid the survivor bias, firms that during the period ceased to be listed on the stock exchange or filed for bankruptcy were included in the sample.

Figure 1 presents the sample decomposition by sectors.

Figure 1 – Sample decomposition by sectors



Source: Own Elaboration

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The figure above shows that the sample of 1,145 firms listed on Euronext is distributed across 10 sectors[4] The most representative sector is Automotive with a total of 242 firms, followed by the Industrial sector with 236 firms, and by the Technology sector which consists of 180 firms.

3.2. Variables

3.2.1. Dependent variable

Total risk is used to capture stock risk, as it simultaneously captures the systematic and specific risk, in line with Aktas et al. (2015) and Le (2019). The stock total risk is computed as follows:

$$Risk_{it} = \sigma(R_{it}) \tag{1}$$

where $Risk_{it}$ represents the total risk of stock *i* in month *t*; $\sigma(R_{it})$ corresponds to the standard deviation of the daily returns of stock *i* in month *t*.

3.2.2. Independent variables

Consistent with Akbar et al. (2021) and Wang (2019), the CCC is used as a proxy for WCM, as it follows:

$$CCC_{it} = DSO_{it} + DSI_{it} - DPO_{it} \tag{2}$$

where CCC_{it} reflects the time between paying to suppliers, selling inventories, and receiving customers for firm *i* in year *t*; DSO_{it} is the average number of days that customers take to pay firm *i* in year *t*; DSI_{it} is the average number of days the inventories are held in the warehouse for firm *i* in year *t*; DPO_{it} is the average number of days that firm *i* takes to pay its suppliers in year *t*.

An analysis of each of the DSO, DSI, and DPO components is also carried out individually.

3.2.3. Control variables

Control variables are used to account for other factors that influence stock risk and are beyond the scopus of our analysis. The stock liquidity is controlled by two alternative

[4] This paper uses the supersector classification provided by Industry Classification Benchmark (ICB), available at https://www.ftserussell.com/data/industry-classification-benchmark-icb, accessed April 10 2021.

illiquidity measures[5]: Amihud (2002) and Fong et al. (2017), lagged one month (LIQ_{it-1}). Investors demand to be remunerated for investing in less liquid assets as proved by Amihud (2002), therefore it is expected a positive relation with stock risk. Leverage corresponds to the ratio between liabilities and total assets. Lev (1974) proved the existence of a positive relation between leverage and systematic risk. Higher leverage can create financial difficulties for firms, and consequently higher risk. The firm size is controlled by the natural logarithm of the total assets. Larger firms experience less information asymmetry (Diamond and Verrecchia, 1991), so a negative relation is expected. The age is controlled by the natural logarithm of the age of the firms. Older firms have lower levels of asymmetry of information, but also greater experience and reputation (Agiomirgianakis et al., 2013), so it is expected a negative relation with stock risk. Tangible fixed assets are proxied by the ratio between tangible fixed assets and total assets. As argued by Prommin et al. (2016) higher tangible fixed assets reduce asymmetry of information, since the benefits associated are easy to observe, being expected a negative relation with stock risk.

3.3. Models

The study uses unbalanced panel data to test the hypothesis, which allows the analysis of different firms over time. The use of panel data models controls and eliminates the influence of unobservable heterogeneity on results (Hsiao, 1985). The Hausman (1978) test is applied to choose between fixed-effects and random-effects models. To choose between ordinary least squares or random effects, the F test is applied. Finally, the Breusch and Pagan (1980) test is performed to choose between ordinary least squares and fixed-effects models.

To test the existence of an optimal point of the CCC, and its components, that minimizes stock risk the following models are estimated:

$$Risk_{it} = \beta_0 + \beta_1 CCC_{it} + \beta_2 CCC_{it}^2 + \beta_3 LIQ_{it-1} + \beta_4 Leverage_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (3)$$

$$Risk_{it} = \beta_0 + \beta_1 DSO_{it} + \beta_2 DSO_{it}^2 + \beta_3 LIQ_{it-1} + \beta_4 Leverage_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (4)$$

[5] Two illiquidity variables are applied because they capture different dimensions of liquidity, adding robustness to the analysis.

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$$Risk_{it} = \beta_0 + \beta_1 DSI_{it} + \beta_2 DSI_{it}^2 + \beta_3 LIQ_{it-1} + \beta_4 Leverage_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (5)$$

$$Risk_{it} = \beta_0 + \beta_1 DPO_{it} + \beta_2 DPO_{it}^2 + \beta_3 LIQ_{it-1} + \beta_4 Leverage_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Tangibles_{it} + \varepsilon_{it} \quad (6)$$

where LIQ_{it-1} represents either the Amihud (2002) or Fong et al. (2017) measure.

4. Results

It can be seen in Panel A of Table II that the average duration of DSO is 93.6 days, being higher than the average DPO duration that is 67.3 days, meaning that firms in this sample pay their suppliers before receiving from their clients (in mean). The DSI is the component that presents the highest average duration, with a value of 128.2 days, being also the component that presents the greatest dispersion, thus indicating that the management of inventories varies greatly between the firms in the sample. The monthly stock risk has an average value of 2.242% (the median is 1.654%). This average is close to the values obtained by Aktas et al. (2015) and by Lee and Kim (1998).

Panel B of Table II presents the Pearson correlation matrix. The correlation between the stock risk and the CCC is negative and statistically significant, suggesting that an increase in the CCC induces a reduction in the stock risk. Additionally, positive, and significant correlations can be verified between stock risk, DSO, and DPO, that is, increases in the time to receive from customers and in the time to pay suppliers, increase stock risk.

From the analysis of the variance inflation factor (VIF) (results are presented in Table A.1 in Appendix 1), it can be concluded that there are no problems of multicollinearity.

Table III shows the results of the regression of fixed effects models of equations (3) to (6). After performing the F, Breusch and Pagan (1980), and Hausman (1978) tests, it was concluded that fixed effects specification ensures the best fit to the sample. Moreover, all regression models were estimated with robust standard errors to avoid heteroscedasticity problems.

Table II –Descriptive statistics

Panel A - Descriptive Statistics											
Variables	**Risk**	**CCC**	**DSO**	**DSI**	**DPO**	**ILLIQ**	**FHT**	**Leverage**	**Size**	**Age**	**Tangibles**
Mean	2.242	90.417	93.664	128.2	67.303	1.532	2.016	57.855	11.77	3.355	1.964
Standard Deviation	2.206	125.79	96.492	167.971	79.527	6.599	4.704	24.39	2.169	0.826	4.844
Maximum	13.746	468.28	402.24	776.57	540.38	85.433	31.793	165.061	16.334	4.812	20.763
Median	1.654	63.927	65.019	76.753	46.103	0.032	0.504	57.172	11.673	3.295	0.505
Minimum	0.000	-104.82	1.329	0.000	3.785	0.000	0.000	3.432	8.584	1.791	0.007
Q3-Q1	1.598	122.83	64.755	123.73	41.759	0.279	1.324	27.642	3.367	1.216	0.580

Panel B - Correlation Coefficients											
Variables	**Risk**	**CCC**	**DSO**	**DSI**	**DPO**	**ILLIQ**	**FHT**	**Leverage**	**Size**	**Age**	**Tangibles**
Risk	1	-0.040***	0.070***	-0.005	0.118***	0.447***	0.731***	0.100***	-0.158***	-0.087***	0.033***
CCC		1	0.123***	0.062***	-0.210***	-0.022***	-0.037***	-0.040***	0.035***	0.141***	-0.034***
DSO			1	0.011***	0.279***	0.084***	0.099***	0.006	-0.185***	-0.097***	0.041***
DSI				1	0.024***	0.002	0.010**	0.017***	0.005	0.022***	0.017***
DPO					1	0.036***	0.070***	0.055***	-0.143***	-0.162***	0.012***
ILLIQ						1	0.536***	0.064***	-0.135***	-0.027***	0.046***
FHT							1	0.064***	-0.185***	-0.027***	0.046***
Leverage								1	0.043***	-0.22***	-0.050***
Size									1	0.190***	-0.172***
Age										1	-0.031***
Tangibles											1

Notes: The table sums the descriptive statistics and Pearson correlation coefficients of the variables applied in the estimated regression models. **Risk** corresponds to the stock risk of firm *i* stock in month *t*; **CCC** is the firm *i* cash conversion cycle in year *t*; **DSO** corresponds firm *i* average customer receivable term in year *t*; **DSI** is firm *i* average inventory turnover term in year *t*; **DPO** represents firm *i* average supplier payment term in year *t*; **ILLIQ** reflects Amihud (2002) illiquidity measure of firm *i* in month *t*; **FHT** represents Fong et al. (2017) of firm *i* in month *t*; **Leverage**

represents the leverage ratio of firm *i* in year *t*; **Size** corresponds to the size of the firm captured by the Ln (Assets) of firm *i* in year *t*; **Age** corresponds the age of the firm, through the Ln (Age) of firm *i* in year *t*; **Tangibles** is the level of tangible fixed assets of firm *i* in year *t*. The p-value values of each coefficient are represented in parentheses. *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively

Source: Own Elaboration

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Table III – Regression results between stock risk and WCM

Dependent Variable: Risk								
	(3)		**(4)**		**(5)**		**(6)**	
CCC	-0.403*** (0.000)	-0.434*** (0.000)						
CCC²	0.323*** (0.000)	0.319*** (0.000)						
DSO			0.357 (0.101)	0.253 (0.257)				
DSO²			-0.202 (0.306)	-0.147 (0.467)				
DSI					-0.441*** (0.000)	-0.373*** (0.004)		
DSI²					0.224*** (0.000)	0.181*** (0.003)		
DPO							0.173 (0.392)	0.269 (0.177)
DPO²							0.207 (0.168)	0.114 (0.430)
ILLIQ$_{t-1}$	4.523*** (0.000)		4.587*** (0.000)		4.252*** (0.000)		4.465*** (0.000)	
FHT$_{t-1}$		12.737*** (0.000)		12.233*** (0.000)		11.693*** (0.000)		12.623*** (0.000)
Leverage	0.847*** (0.000)	0.795*** (0.000)	0.870*** (0.000)	0.802*** (0.000)	1.024*** (0.000)	0.957*** (0.000)	0.839*** (0.000)	0.770*** (0.000)
Size	-0.060*** (0.000)	-0.055*** (0.000)	-0.061*** (0.000)	-0.051*** (0.000)	-0.057*** (0.000)	-0.050*** (0.000)	-0.056*** (0.000)	-0.051*** (0.008)
Age	-0.064 (0.730)	-0.072 (0.686)	-0.062 (0.736)	-0.069 (0.698)	-0.119 (0.551)	-0.131 (0.495)	-0.074 (0.690)	-0.080 (0.651)
Tangibles	0.001 (0.627)	0.002 (0.350)	0.001 (0.735)	0.002 (0.438)	0.000 (0.867)	0.002 (0.874)	0.001 (0.643)	0.002 (0.443)
β_0	2.646*** (0.000)	2.476*** (0.000)	2.533*** (0.000)	2.327*** (0.000)	2.734*** (0.000)	2.574*** (0.000)	2.540*** (0.000)	2.357*** (0.000)
No. of observations	63.220	66.098	64.205	67.190	48.091	50.119	65.613	62.733
F	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
Hausman	0.000***	0.000***	0.000***	0.010**	0.000***	0.0040***	0.000***	0.001***
Breusch-Pagan	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***

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Notes The table summarizes the results obtained when estimating the models of equations (3) to (6) whose dependent variable is **Risk** corresponds to the stock risk of firm *i* stock in month *t*; **CCC** is firm *i* cash conversion cycle in year *t*; **CCC²** represents the squared variable of firm *i* cash conversion cycle in year *t*; **DSO** denotes firm *i* average customer receipt term in year *t*; **DSO²** represents the squared value of firm *i* average customer receipt term in year *t*; **DSI** denotes the average inventory turnover period of firm *i* in year *t*; **DSI²** denotes the squared value of the average inventory turnover period of firm *i* in year *t*; **DPO** depicts the average payment term to suppliers of firm *i* in year *t*; **DPO²** is the squared value of the average payment term to suppliers of firm *i* in year *t*; **$ILLIQ_{t-1}$** represents Amihud (2002) illiquidity measure of firm *i* in month *t-1*; **FHT_{t-1}** is Fong et al. (2017) of firm *i* in month *t-1*; **Leverage** correspond to the leverage ratio of firm *i* in year *t*; **Size** represents the size of firms captured by the Ln (Assets) of firm *i* in year *t*; **Age** denotes the age of the firm, through the Ln (Age) of firm *i* in year *t*; **Tangibles** is the level of tangible fixed assets of firm *i* in year *t*; **β0** represents the constant of the regression models. The p-value values of each coefficient are represented in parentheses. *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

Source: Own Elaboration

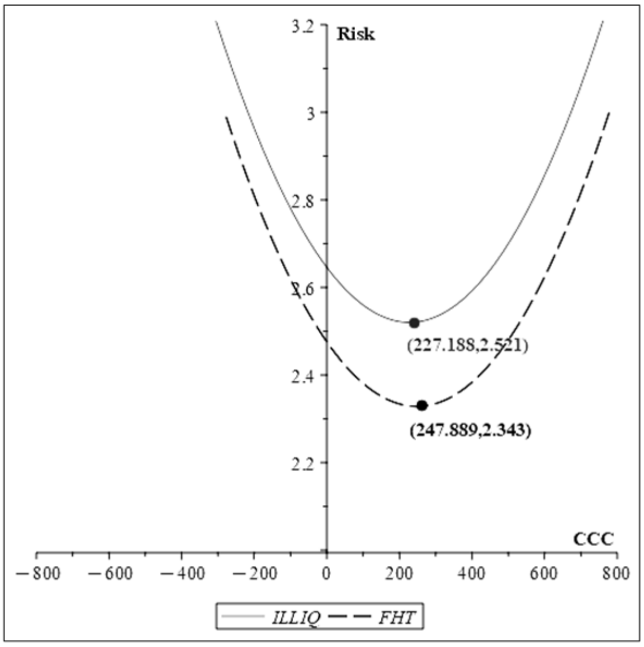
The results of regression (3) suggest that there is an optimal CCC point that minimizes stock risk, since the coefficient associated with CCC^2 reveals a positive sign and it is statistically significant at 1%, regardless of the illiquidity measure used. Thus, this result supports Hypothesis 1 and corroborates the results of Akbar et al. (2021) and Aktas et al. (2015), indicating the existence of a U-shaped relation between WCM and stock risk. By examining the break-even point[1] of CCC (calculated as $-\beta 1/2\beta 2$), it is found that the optimal point has a duration of 227.2 days and 247.9 days, when controlling stock illiquidity with the measure of Amihud (2002) and Fong et al. (2017), respectively.

These findings are consistent with the idea that WCM is met with cost-benefit trade-offs that act as a source of risk because they impact the volatility of firms' cash flows. Consequently, building on market efficiency, these trade-offs are incorporated into stock price raising in a U-shaped relation.

Figure 2 shows the relation between CCC and stock risk, which is a concave up function.

[1] The CCC value and its components were divided by 365 days. In this sense, to perform the break-even point analysis, it is necessary to divide the values presented by 365 and by 365^2.

Figure 2 – Relation between CCC and stock risk



Source: Own Elaboration

When examining the results of equation (4), it is possible to observe that the coefficients associated with DSO^2 do not reveal statistical significance, thus rejecting hypothesis *H1a*.

However, the results of equation (5) support hypothesis *H1b*, since the coefficients of DSI^2 are positive and statistically significant at a 1% level. These results suggest the existence of a U-shaped relation, indicating the existence of an optimal DSI duration which firms should seek to minimize stock risk. The results cannot be compared with the results of other authors since this is the first study to perform the analysis of an optimal DSI point that minimizes stock risk. By examining the break-even point of the DSI, it is concluded that the optimal DSI duration is 358.4 days and 375.9 days, when controlling illiquidity by the measure of Amihud (2002) and Fong et al. (2017), respectively.

Figure 3 illustrates the nonlinear behaviour between DSI and stock risk.

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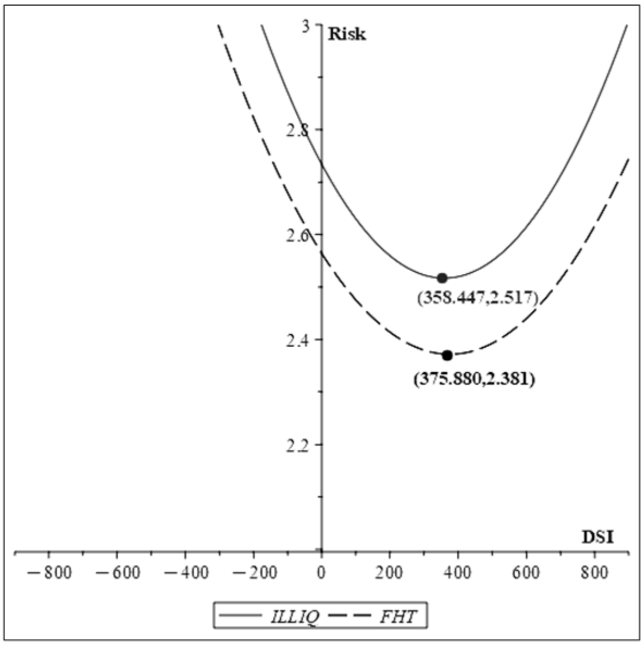
Figure 3 – Relation between DSI and stock risk



Source: Own Elaboration

Theoretically, the U-shaped relation may occur due to the trade-offs associated with inventory management that are perceived by investors and incorporated into the stock risk. Accordingly, having higher inventories reduce firms' risk, by avoiding stockout risk and production breakdown (Blinder and Maccini, 1991; Jose et al., 1996; Mathuva, 2010; Sagan, 1955). However, the extent to which firms can reduce their risk by having higher inventories is limited by the costs of storage, insurance, and obsolescence (Afrifa and Tingbani, 2018; Altaf and Shah, 2018; Blinder and Maccini, 1991), and by the financial and opportunity costs associated with a higher investment in WC.

The results from the estimation of regression (6) show that the coefficients associated with DPO^2, and DPO, are not statistically significant, and thus do not support hypothesis *H1c*.

Regarding the control variables, it can be seen in all regressions (3) to (6) the existence of positive and significant coefficients associated with the leverage of firms, suggesting that the increase in debt leads to an increase in stock risk, corroborating the results of Lev (1974). The Amihud (2002) and Fong et al. (2017) measures of illiquidity have positive and statistically significant coefficients, which supports the idea that more illiquid stocks have a higher risk. The Size variable has negative and statistically significant coefficients in all the models, which means that larger firms present a lower stock volatility. The coefficients of the control variables Age and Tangibles are not statistically significant.

In sum, this paper presents evidence that there is an optimal point of CCC that minimizes firms' stock risk, in the European context. Additionally, the findings provide evidence of an optimal DSI point, indicating that optimal inventory management plays a crucial role in achieving an optimal WCM.

5. Conclusion

The question about the impact WCM has on stock risk is not settled, as the limited previous research presents mixed results. Even though extensive literature recognizes the existence of multiple trade-offs on WCM that can be the underlying reason for this lack of consensus, only a few studies explore the likelihood of a non-linear relation between WCM and stock risk. Thus, this paper studies the existence of an optimal point of the CCC, and its components, that allows minimizing the stock risk of 1,145 firms listed in five Euronext exchanges (Amsterdam, Brussels, Dublin, Lisbon, and Paris), between 2011 and 2019.

In the analysis, fixed effects models with the quadratic function of the CCC and its components are applied to capture an optimal point of the WCM. Stock risk is captured through the standard deviation of observed stock returns.

Results support a U-shaped relation between WCM and stock risk. More specifically, the results indicate that it might be possible to minimize stock risk by achieving an optimal CCC and DSI duration. These results are consistent with the literature that acknowledges the existence of trade-offs within WCM, and that building on market efficiency should be incorporated into stock risk. Accordingly, practicing a higher CCC enables firms to reduce cash flow volatility by granting credit to clients, avoiding stockout risk, and obtaining discounts from suppliers for earlier payments. However, the extent to which firms can reduce the volatility of cash flows by practicing a higher CCC is limited by the problems that may occur due to a lack of cash liquidity (Bolek, 2013), which requires a higher investment in WC, and consequently leads to a greater need for external financing (Deloof, 2003; Sagan, 1995). The same logic applies to DSI: higher inventories reduce firms' risk by avoiding stockout risk and production breakdown (Blinder and Maccini, 1991; Jose et al., 1996; Mathuva, 2010; Sagan, 1955). However, storage, insurance, and obsolescence costs (Afrifa and Tingbani, 2018; Altaf and Shah, 2018; Blinder and Maccini, 1991), restricts firms' ability to reduce their risk by holding higher inventories.

This study contributes to the growth of the literature that unveils the impact of WCM on stock risk, by providing evidence that supports the existence of a U-shaped relation between WCM and stock risk. The major findings of Akbar et al. (2021) and Aktas et al. (2015) are relatable to the results obtained in this paper. However, two features set this paper apart from the existing literature. First, Akbar et al. (2021) and Aktas et al. (2015) have limited their scope to the existence of an optimal CCC or WC. This paper advances research by exploring not only a non-linear relation between CCC and stock risk, but also extending this analysis to its components, which is necessary in order to clarify how trade-offs of CCC components influence this relation. Second, previous literature has mainly been focused on US firms, being this the first paper to explore this relation in the European context, which is a context where firms tend to invest more in WC than US firms (PwC, 2019).

The results of this paper not only have a significant contribution to the literature, but may also have potential implications for managers, shareholders, and investors. From the managers perspective, the findings can enhance their decision-making by empirically proving the existence of a non-linear relation between WCM and stock risk. More specifically, this study proves the existence of an optimal point of CCC and of an optimal point of DSI that minimizes stock risk, which highlights the fact that managers should balance their investment in WC and in inventories, to minimize stock risk. The results can also help shareholders that find themselves questioning the impact that WCM may have on the risk of their stocks, by specifying how the trade-offs of WCM influence stock risk. The insights from this study can also be particularly valuable for investors when selecting stocks for their portfolios, since they suggest that including firms with optimal CCC and DSI can minimize their portfolio risk.

It is considered pertinent to analyse in future studies a non-linear relation between the CCC and its components and the specific and systematic risk. This decomposition is pertinent since the WCM may impact the specific risk and the systematic risk in different ways. In one hand, firms' WCM may minimize stock specific risk by reducing their operational and financial risk. Firms can reduce their operational risk by avoiding cash flow problems due to higher investment in WC (Bolek, 2013). In opposition, lower investment in WC reduces firms' financial risk, by guaranteed cash liquidity that reduces the need for external finance (Deloof, 2003; Sagan, 1995). On another hand, it is also possible that an optimal WCM reduces systematic risk, by providing flexibility to firms to react quickly to unexpected market changes, by delaying payments to suppliers, and granting credit to clients. It would also be interesting to assess in future studies whether the results vary according to the financial situation of the firms, as this could have a significant influence on the way firms manage their components of WCM and on stock risk.

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Appendix 1

Table A.I – VIF analysis of the models of equations (3) to (6)

Dependent Variables: Risk							
Panel A – Models with control variable $ILLIQ_{t-1}$							
CCC	5,270	**DSO**	10,070	**DSI**	9,167	**DPO**	8,185
CCC^2	5,207	**DSO^2**	10,020	**DSI^2**	9,100	**DPO^2**	8,027
$ILLIQ_{t-1}$	1,027	**$ILLIQ_{t-1}$**	1,032	**$ILLIQ_{t-1}$**	1,023	**$ILLIQ_{t-1}$**	1,028
Leverage	1,011	**Leverage**	1,013	**Leverage**	1,026	**Leverage**	1,026
Size	1,067	**Size**	1,081	**Size**	1,060	**Size**	1,085
Age	1,060	**Age**	1,034	**Age**	1,036	**Age**	1,056
Tangibles	1,022	**Tangibles**	1,025	**Tangibles**	1,019	**Tangibles**	1,022
Panel B – Models with control variable FHT_{t-1}							
CCC	5,232	**DSO**	10,339	**DSI**	9,074	**DPO**	8,010
CCC^2	5,167	**DSO^2**	10,294	**DSI^2**	9,014	**DPO^2**	7,865
FHT_{t-1}	1,040	**FHT_{t-1}**	1,050	**FHT_{t-1}**	1,043	**FHT_{t-1}**	1,042
Leverage	1,013	**Leverage**	1,015	**Leverage**	1,030	**Leverage**	1,031
Size	1,084	**Size**	1,099	**Size**	1,037	**Size**	1,099
Age	1,060	**Age**	1,034	**Age**	1,190	**Age**	1,057
Tangibles	1,021	**Tangibles**	1,024	**Tangibles**	1,019	**Tangibles**	1,021

Notes: The table presents the results of the VIF analysis for the models of equations (3) to (6). **Risk** corresponds to stock risk of firm *i* in month *t*; **$ILLIQ_{t-1}$** reflects Amihud (2002) illiquidity measure of firm *i* in month *t-1*; **FHT_{t-1}** is Fong et al. (2017) of firm *i* in month *t-1*; **CCC** represents the cash conversion cycle of firm *i* in year *t*; **CCC^2** denotes the squared variable of the cash conversion cycle of firm *i* in year *t*; **DSO** corresponds to the average customer receivable term of firm *i* in year *t*; **DSO^2** represents the squared value of the average customer receivable term of firm *i* in year *t*; **DSI** represents the average inventory turnover term of firm *i* in year *t*; **DSI^2** is the squared value of the average inventory turnover term of firm *i* in year *t*; **DPO** corresponds the average payment term to suppliers of firm *i* in year *t*; **DPO^2** denotes the squared value of the average payment term to suppliers of firm *i* in year *t*; **Leverage** represents the leverage ratio of firm *i* in year *t*; **Size** corresponds to the size of firms captured by the Ln (Assets) of firm *i* in year *t*; **Age** denotes the age of the firm, through the Ln (Age) of firm *i* in year *t*; **Tangibles** correspond to the level of tangible fixed assets of firm *i* in year *t*; **β_0** is the constant of the regression models.

Source: Own Elaboration